Production and Evolution of ϕ Mesons in Au+Au and p+p Collisions at $\sqrt{s_{NN}} = 200$ GeV

Eugene Yamamoto
Lawrence Berkeley National Laboratory, 1 Cyclotron Rd, Berkeley, CA 94720
Jingguo Ma
University of California, Department of Physics and Astronomy, Los Angeles, CA 90095
for the STAR Collaboration

The production of ϕ mesons in relativistic heavy ion collisions has been of great interest at the AGS, SPS and RHIC. In elementary collisions, the production of ϕ mesons, the lightest bound state of strange quarks ($s\bar{s}$) is suppressed because of the OZI rule. In heavy ion collisions, however, strange quarks are produced copiously and a strangeness enhancement is observed. At RHIC, where long range correlations exist, it becomes difficult to disentangle information about the early phase of the collision with final state hadronic interactions. The ϕ meson, with its small hadronic cross-section, may provide a clean probe to study the properties of heavy ion collisions before hadronic interactions.

A naive interpretation of the ϕ enhancement in Au+Au collisions would be that the ϕ is produced hadronically via $K\bar{K} \to \phi$. Hadronic rescattering models predict an increase in the $\langle p_t \rangle$ and ϕ/K^- ratio as a function of the number of participant nucleons (N_{part}). The R_{CP} of the ϕ meson is important to help descriminate between mass and particle species ordering. R_{CP} as defined here is the $\langle N_{part} \rangle$-normalized ratio of the central data to the peripheral data [1].

Figure 1 shows the preliminary transverse mass distributions from Au+Au (circles) and p+p collisions at 200 GeV. The spectra are for ϕ's in the rapidity range $|y| < 0.5$. For clarity, the distributions for different centralities were scaled by a factor for Au+Au collisions. The $\langle p_t \rangle$ increases from p+p to Au+Au collisions but is independent of collision centrality. In p+p collisions, the transverse mass distribution is fit well by a power-law function as shown in Figure 1. Pythia also produces a power-law spectrum. In Pythia, ϕ production involves $s\bar{s}$ pair production in the string with the string $s(\bar{s})$ picking up a $\bar{s}(s)$ from the sea to produce a ϕ meson. The insert shows the R_{AA} for the ϕ compard with the Λ and K^0_S and shows that the ϕ behaves like the K^0_S meson and not the similarly massive Λ baryon[2].

[1] C. Adler *et al.*, Phys. Rev. Lett. **89**, 202301 (2002).
[2] P. Sorensen, "Particle dependence of elliptic flow in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV," arXiv:nucl-ex/0305008.

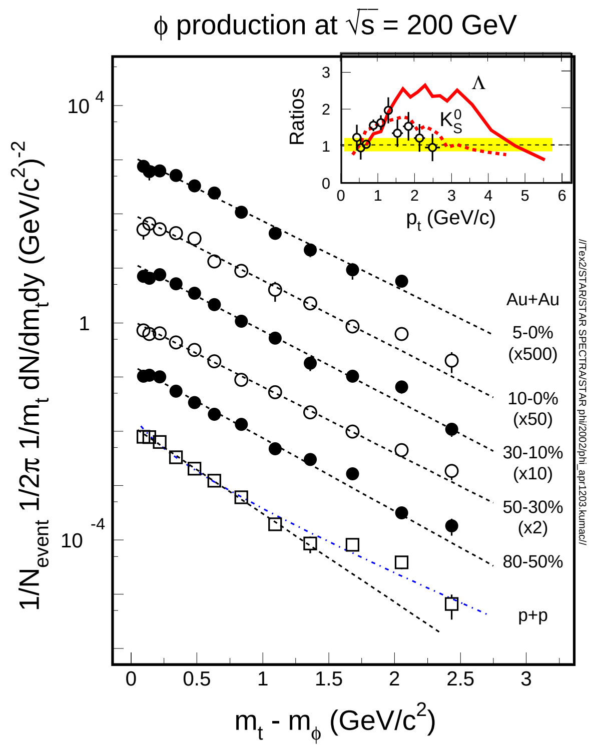

FIG. 1: Preliminary transverse mass distributions from Au+Au (circles) and p+p (squares) collisions at 200GeV. The data were extracted from $|y| < 0.5$. For clarity, each distribution for different centrality was scaled by a factor from Au+Au collisions. Dashed-lines represent the exponential fit to the distributions and the dotted-dashed-line is the result of power-law fit to p+p data. Only statistical errors are shown. The bin to bin systematic uncertainties are estimated to be less than 5% and the systematic error in the overall normalization is estimated to be less than 10% and 15% for all centrality bins for Au+Au and p+p collisions, respectively. Insert: The ratio of central (top 5%) over peripheral (80-50%), normalized by the number of the participants, vs. transverse momentum. The yellow-band indicates the uncertainties in the estimation of $\langle N_{part} \rangle$. Solid and dashed-lines show the similar ratios for the ϕ and K^0_S.